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Big Data: The Enabler of "the Right Materiel, the Right Place, the Right Time"?

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AIM

1. The intent of this service paper is to discuss the applicability of Big Data concepts to operational support, using aspects of the Defence Supply Chain (DSC) as the business case. Additionally, it intends to illustrate how Big Data can be used by Canadian Joint Operations Command (CJOC) to facilitate interoperability between domains and contribute to the agility, flexibility, sophisticated awareness and advanced capability demanded in Strong Secured Engaged (SSE).[1]

INTRODUCTION

2. Modern conflict is evolving quickly and increasing in pace and scope, demanding quicker responses and, therefore, shorter planning windows and decision cycles. It is, and will increasingly be, critical for the Canadian Armed Forces (CAF) to leverage technology to stay relevant in the operational environment. While matching or keeping ahead of near-peer competitors, the CAF must also keep pace with our allies to remain interoperable. A transition away from a human and hardware-centric organization to one that is software-empowered and able to exploit and analyze data to provide an informed advantage is required.[2]

3. As support is fundamental across all military activities and domains,[3] it is imperative it has the flexibility and versatility to adapt quickly to changing mission priorities and tactics. Foresight and adaptability must be built into support plans; highly maneuverable forces need highly responsive logistics. Sustainment must modernize at pace with the changes and advances in the conduct of operations. To date, CJOC and the supporting elements have ensured adequate sustainment. However, this has been due primarily to people's creativity, experience and ingenuity and despite the known shortfalls within the DSC. Based on personnel resource challenges and the pace of advancing technologies, a tipping point is approaching and we can no longer rely so heavily on our people to ensure effective operational support.

4. In this technological age, useful data can be gleaned from varied sources such as mobile devices, trackers, sensors, log files, web and social media, and, of course, transactional data. This Big Data can "deliver a wealth and variety of mission-critical data to today's warfare".[4] The DSC generates copious transactional data which is prime to be combined with outside sources which impacts processes throughout support

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[1] Department of National Defence, *Strong, Secure, Engaged: Defence Policy*. Ottawa: DND, 2017, 14.
[2] Amreen Khan, "Big Gains Foreseen For Big Data In Military", *in Defense World.Net,* https://www.defenseworld.net/feature/12/Big_Gains_Foreseen_For_Big_Data_In_Military_Applications#.Ye5DENHMKuV.
[3] Department of National Defence, CFJP 4.0, B-GL-005-400/FP-001, *Support*. Ottawa: Canadian Forces Warfare Centre, Oct 2016, 1-1.
[4] Amreen Khan, "Big Gains…"

function. CJOC, as a multi-domain, multi-theatre Force Employer, requires global visibility of assets and improved analytics from historic data, first and foremost. This then needs to be layered with predictive analytics abilities that also use open-source data to ensure that the "the right stuff, at the right place, at the right time" and (although secondary) as economically as possible. Therefore, operational support, specifically materiel support, is a prime example where Big Data concepts could be effectively applied and result in added value to operations through improved logistics intelligence.

DISCUSSION

Big Data

5. Oracle™, one of DND's Enterprise Resource Platforms (ERPs),[5] defines Big Data as "data that contains greater **variety**, arriving in increasing **volumes** and with more **velocity**"[6], referred to colloquially as the "3Vs". The definition in DND's Data Strategy also includes the caveat that, because of these 3Vs, Big Data "cannot be easily stored or analyzed with traditional methods".[7] But, regardless of the challenges, Big Data is invaluable to many industries and defence is no exception

6. By virtue of the vast network of programs, sensors, and databases utilized within DND, transactional data volume is not a challenge from a creation standpoint. For example, within the DSC, data is constantly collected from user transactions across all of DND lines of support. Pairing ERP data with open-source data would result in high velocity and varied data collection. This data can be put into context or combined in innumerable ways to provide information to provide decision support and achieve operational objectives. Thus, operation support, specifically materiel, is an ideal business case for the applicability of Big Data.

7. The benefit of Big Data is that more data sources can be combined in more ways to create more complete information. Conversely, because of the variability of Big Data not all sources will provide data at the same pace or regularity meaning data flows are unpredictable[8]. But the unpredictability is outweighed by the potential value that Big Data can provide, such as improved resource management, informing risk acceptance decisions, and identifying opportunities.

8. It must be noted that Big Data must also have **value** and **veracity**.[9] Data is just data until it is assigned value, be it as metadata or as part of a query. Currently, much of DND's data is considered "dark data" in that the raw data is collected and stored, but it is

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[5] ERPs are standardized software solutions that connect multiple business functions into one integrated system sharing a single database. GOC has two ERPs approved by Treasury Board, Oracle and SAP
[6] Oracle Canada, What is Big Data?, accessed 14 January 2022, https://www.oracle.com/ca-en/big-data/what-is-big-data/.
[7] Department of National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy*, Ottawa: DND, 2019, 24.
[8] SAS, Big Data:What it is and Why it Matters, accessed 14 January 2022, https://www.sas.com/en_ca/insights/big-data/what-is-big-data.html.
[9] Oracle Canada.

not yet used in a meaningful way[10]. It is here, and with data veracity (data quality), where DND faces significant challenges, which will be discussed later in this paper.

Operational Support Use Cases

9. Logistics firms, specifically the supply chain industry, have been using Big Data applications since their inception[11]. Many sources cite successes in the areas of transport, warehousing optimization, consolidation of freight, and Just-In-Time (JIT) delivery, amongst others. The use cases proposed herein will require these successes to be studied and best practices employed where applicable; DND is late to the Big Data game and cannot afford to "reinvent the wheel".

10. A vital use case for Big Data is to assist in the real-time visibility of assets. This is a baseline requirement upon which most other support use cases will rely. It depends upon data collection at all stages along the DSC, including when materiel is in the hands of commercial entities and through a various means such as telematics, geomatics, RFID, and transactional data. However, the correlation of this data is challenged by issues with interconnectivity and data sharing, as illustrated by the long-standing and yet to be completed Automatic Information Technology project.[12] Although not simple, this total asset visibility is imperative to provide sustainment options that support joint and multi-domain operations. Specifically, it will allow CJOC a near real-time global perspective of what (Canadian) materiel is available within an area of operations and across all domains and lines of support.

11. Another use case is the correlation and analysis of historical and real-time DSC data, referred to as Big Data Analytics.[13] These analytics should first be used institutionally to identify optimization opportunities, find efficiencies, and inform business decisions such as procurement schedules and warehouse levels; essentially enable efficient logistics throughout the materiel life-cycle. For operations, these types of analytics can be used to ensure balanced levels of materiel holdings are assigned to a theatre of operations based on the force package, environment, and location. The near real-time nature of these analytics could be leveraged to provide insight in an ongoing manner to help successfully manage operations[14]. For example, this modeling should result in better inter-component operational support as it will help to identify instances

[10] Data Strategy, 13.
[11] Samuel Fosso Wamba, Gunasekaran Angappa, Papadopoulos Thanos, and Eric Ngai. "Big Data Analytics in Logistics and Supply Chain Management." *International Journal of Logistics Management* 29, no. 2 (2018): 478. https://www.proquest.com/scholarly-journals/big-data-analytics-logistics-supply-chain/docview/2047959570/se-2?accountid=9867.
[12] This project is aimed at total asset visibility through RFID technology. It is not yet complete despite launch in 2014. FOC is not anticipated before 2026. http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1589.
[13] Analytics India Magazine, "Using Big Data in Military Operations: This is how future wars will be Fought", last accessed 14 January 2022, https://analyticsindiamag.com/using-big-data-in-military-operations-this-is-how-future-wars-will-be-fought/.
[14] Oliver Freeman, "The Role of AI and Big Data in Modern-Day Logistics", on *Supply Chain*, 11 December, https://supplychaindigital.com/logistics-1/role-ai-and-big-data-modern-day-logistics.

where transferring materiel between force elements, even those not part of ongoing operations, is the most effective option.

12. If the first two use cases can be realized, the subsequent logical use for Big Data is for advanced analytics or modelling. Data is taken one step further and used to predict trends and patterns or prescribe action[15]. In the case of operational support, it could combine DSC data with open source and external data[16] to provide a clearer picture of available sustainment options or impending issues. Some examples include weather reports, social media, and global news. This data can be combined with predictive data from the DSC, such as forecasted usage, to enhance decision-making by providing likely outcomes and an informed path forward.

13. The key for all of these use cases is that they require advanced technologies such as machine learning (ML) or artificial intelligence (AI) to enable near real-time analysis[17]. The 3Vs make sifting through Big Data too arduous for humans. This capability requires a cloud-based solution combined with the development of trustworthy analytics but, done right, Big Data and AI could result in predictive technology capable of supporting operations without significant human intervention[18]. This, in turn, would allow better employment of finite military personnel resources where they are most required to achieve operational objectives. However, ML and AI need a high level of data maturity and, as will be discussed in the next section, realizing AI capability is challenged by many factors faced by DND today.

Situating Big Data Applicability into the CAF/DND Reality

14. Several key issues impact DND and the CAF's capacity to exploit Big Data. First, organizational digital functionality does not yet offer decision-ready information. Specifically, the department has poor data quality across a complicated network of stand-alone programs and data warehouses.[19] Additionally, there is a maze of policies that often prevent the timely adoption of emerging technologies, primarily due to procurement and security requirements. Another challenge common across many DND programs and platforms is that they are not basic commercial applications; they have either been modified from the commercially available version or are a bespoke product created to meet DND-specific need. This, paired with the omnipresent security issue, makes it challenging to bring in outside contractors to apply industry solutions or to interconnect and update programs. It is exacerbated by the fact that, internally, system expertise is siloed across the organization and data specialists are generally "one deep". Essentially, this means that DND is still at the foundational stage of digitalization, which focusses on governance and culture, and must make significant progress to be at the data maturity

[15] *Ibid.*
[16] Such as from the Five Eyes (FVEY) and other allies.
[17] DHL and IBM, "Artificial Intelligence in Logistics", Germany: DHL, 2018, http://dhl.lookbookhq.com/ao_thought-leadership_digital-analytics-2/research-report_artificial-intelligence-in-logistics, 10.
[18] *Ibid*, 22.
[19] Placemat, "The Digital Transformation Primer: The Case for Digital Transformation".

required to effectively implement Big Data and advanced technologies.[20]

15. The DSC is illustrative of the greater data challenges faced by DND. It is a collection of systems that is not a coherent whole, with diverse data collection points and data held outside of the ERP[21]. Furthermore, it is plagued by widespread stock shortages and other issues, which, added to inconsistent data quality, have resulted in late materiel deliveries and poor analytics[22]. Although numerous projects are underway to resolve these foundational issues[23], they alone are insufficient. Performance improvement is dependent on the success of the DRMIS Modernization Project which centers on ERP migration to a cloud-based solution[24]. This will be a transformational upgrade that will set the support function and the DSC up for success in the future. If implemented well, it will be an intelligent enabler of operational readiness.

16. The potential value of the untapped data held across the organization is well understood in DND. Accordingly, numerous modernization initiatives are underway with the unifying intent to first digitize and then digitalize[25] how we do business. The common goal is to shift from platform-centric and human-driven to systems-centric and data-driven. Although keystone documents contextualize the requirements and limitations of this shift[26], the challenge is ensuring that all of the initiatives work in tandem and with a common vision. For example, it is essential that the Operational Sustainment Modernization (OSM) project and the PDC2 project remain closely linked to support operations across domains effectively, both now and in the future.

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[20] Defence Administration Orders and Directives: 6500-0, Data Management and Analytics, last accessed 14 January 2022.
[21] Department of National Defence*, Defence Supply Chain Governance: Charter*, Ottawa: DND, 2019, 6.
[22] Office of the Auditor General, *Reports of the Auditor General of Canada to the Parliament of Canada: Report 3 Supplying the Canadian Armed Forces*, Ottawa: OAG, 2020. https://www.oag-bvg.gc.ca/internet/English/parl_oag_202007_03_e_43574.html.
[23] Examples include but are not limited to the Modernization and Integration of Sustainment and Logistics (MISL) program, Materiel Identification, legacy data clean-up initiatives (multiple) and the Automated Information Technology (AIT) Project.
[24] SAP™ S2/Hana.
[25] Digitization: analogue data is converted to digital data. Digitalization: operational processes transformed through the application of digital technologies.
[26] DAOD 6500-0 Data Management and Analytics, DND and CAF Data Strategy, and The Data Governance Framework.

CONCLUSION

17. It will be critical for DND to exploit data to achieve an advantage in the future operational environment. Big Data can be a crucial enabler, and operational support functions should be at the forefront of digitization and Big Data initiatives. Although less "shiny" than technology use cases for the other operational functions, effective and modern support will be required for operations in all domains. Furthermore, despite the noted challenges within the DSC, the supply chain and logistics writ large are areas where the value of Big Data has been proven in industry.

18. The use cases presented in this paper focused on leveraging Big Data to deliver on the principles of support, specifically foresight, economy, flexibility, cooperation, visibility and responsiveness[27]. They would offer global asset visibility, business analytics for better option analysis, and predictive analytics for decision support. The use cases also illustrate that an evolution of operational support needs to occur to keep meeting the demands of modern operations in a multi-domain environment.

RECOMMENDATIONS

19. Data is not information on its own; it needs to be assigned value and combined accordingly. Additionally, successful analytics and AI/ML applications are complex and can take years to develop. Accordingly, now is the time for CJOC to determine potential data sources, the specific data points to correlate, and the information they want the data to provide. Additionally, DND systems should be prioritized for digitation to focus first on those with the most potential to reduce cognitive overload and give the most decision-making support.[28] Operational support systems should be top priorities due to the role sustainment plays across all domains and operational functions. Moreover, its close liaison with the OSM and DRMIS Modernization teams is recommended to ensure that the transition to the cloud solution is implemented well and retains data analytics capabilities.

20. Optimization of operational support relies heavily on externally sourced information. Accordingly, CJOC should ensure logistics data points are considered in intelligence gathering activities and placed where they can be combined with historical and real-time data points to enable accurate predictive analytics. The more data collected, the more complete story it can tell. The potential sources of data are endless, limited only by storage capability, and even data that is not yet tied to specific analytic may still have value in an emergent scenario in the future.[29]

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[27] CFJP 4.0: *Sustain,* 1-3.

[28] Emma Helfrich, "Managing the Military's Big Data Challenge", *Military Embedded Systems*, 4 August 2020, https://militaryembedded.com/ai/big-data/managing-the-militarys-big-data-challenge.

[29] The JAIC, "A roadmap to getting AI Ready", *Defense: DoD's Artificial Intelligence Blog,* 18 June 2020, https://www.ai.mil/blog_06_18_20-a_roadmap_to_getting_ai_ready.html.

21. Finally, although notably challenging in this time of limited personnel resources, it is recommended that CJOC assign dedicated staff to the above recommendations. It is imperative that this vital enabler is given constant and devoted attention and not assigned as a secondary duty to already fully employed members or left entirely in the hands of other stakeholders. CJOC, as the force employer, *must* ensure that it is fully engaged in the modernization of operational support. Indeed, dedicated attention will likely always be required as new data sources will emerge, data models and analytics will need to be refined to answer new questions, and security protocols will change. The investment of resources now, however painful, will pay dividends when Big Data results in decision-ready information.

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